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Theme Session on Census of Marine Life:
Turning Concept into Reality

Assessment of the Falkland Islands population of Argentine hake *Merluccius hubbsi.*

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ABSTRACT

Spanish vessels fish for the Argentine hake, *Merluccius hubbsi* both in Falkland Islands Conservation Zones and in high seas waters along the shelf edge to the north of the islands. Data are collected by the Falkland Islands Fisheries Department, Instituto Español de Oceanografía and Asociación Nacional de Armadores de Buques Congeladores de Pesca de Merluza. Data from these three sources were combined, with the aim of producing assessments of *M. hubbs*i. There was no relationship between abundance indices for Falkland Islands waters and high seas areas, suggesting little interaction between the populations in the two areas. Virtual population analysis suggested that the spawning stock biomass in Falklands waters declined from approximately 60,000 t in 1987 to about 15,000 t in the early 1990s but has since made a partial recovery to approximately 20,000 t. However, low recruitment levels are, apparently, impeding the recovery of the population. The abundance trend contrasts with a continued decline suggested by assessments of the population in Argentine waters, implying some independence of the adult populations in the two areas. Nonetheless, it is likely that recruitment to the population is affected by processes not explained by the available data.

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INTRODUCTION

The hake *Merluccius hubbsi* is the main finfish species exploited by fisheries in the southwest Atlantic. Fisheries operate in the Argentine and Uruguayan EEZs, the conservation zones around the Falkland Islands, and high seas areas. The identity of and interrelationships between populations fished in these areas are poorly understood.

The EC Study Project "Data collection for stock assessment of two hakes Falkland and in international waters of the SW Atlantic" brought together various organisations concerned with hake fisheries in the southwest Atlantic. Data were provided by the Falkland Islands Fisheries Department (FIFD), which monitors fisheries within the Falkland Islands conservation zones, Instituto Español de Oceanografía (IEO) which places observers aboard Spanish vessels operating in the area, and Asociación Nacional de Armadores de Buques Congeladores de Pesca de Merluza (ANAMER) which collects effort and landings data from vessels of affiliated companies and provided observers for the project.

Amongst the aims of the project were the identification and assessment of stock units in the fishing areas considered. Catch and effort data were used to explore hypotheses about the interrelationship between populations fished in the various fishing areas covered by the data.

FISHING AREAS AND HYPOTHESES CONSIDERED

Data were available from three distinct areas:
A. Waters enclosed by the Falkland Islands conservation zones.
B. A high seas area on the continental shelf and slope at around 46ºS.
C. A similar high seas area at 42ºS.

Data from area C were sparse, so research concentrated on the fisheries in areas A and B. Three of the main hypotheses concerning stock identity are presented in Fig. 1. A consideration of each hypothesis is given below.

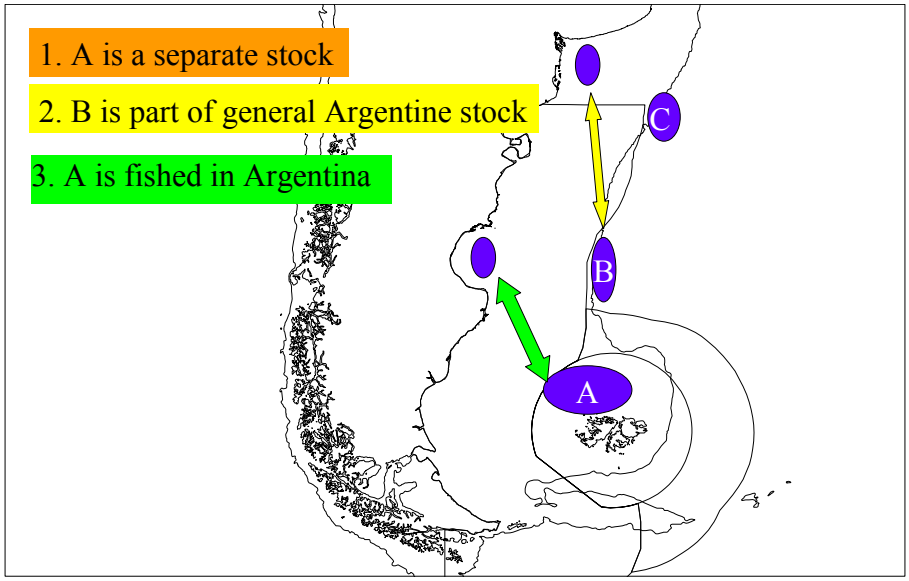

Figure 1. The three fishing areas from which data were available (A, B and C) with illustrations of the main hypotheses considered in this study. Unlabelled blue ovals represent known inshore nursery areas.

HYPOTHESIS 1: Area A contains a separate stock that warrants an independent assessment. It is not substantially linked to Area B or to Argentine waters.

This hypothesis suggests that FIFD data can be used independently to assess the stock fished in the Falklands conservation zones. This was done by Tingley et al. (1995) whose results suggested that the stock declined between 1987 and 1991. We performed two assessments, using a Schaefer production model and VPA tuned to CPUE weighted by inverse standard error (Fig. 2).

Although the production model consistently overestimated biomass compared to the VPA, and the timing of events differed between the two methods, both suggested the same general pattern consisting of a dramatic decline in the late 1980s followed by a partial recovery towards the end of the 1990s. The uncertainty in the VPA was particularly high towards the end of the series.

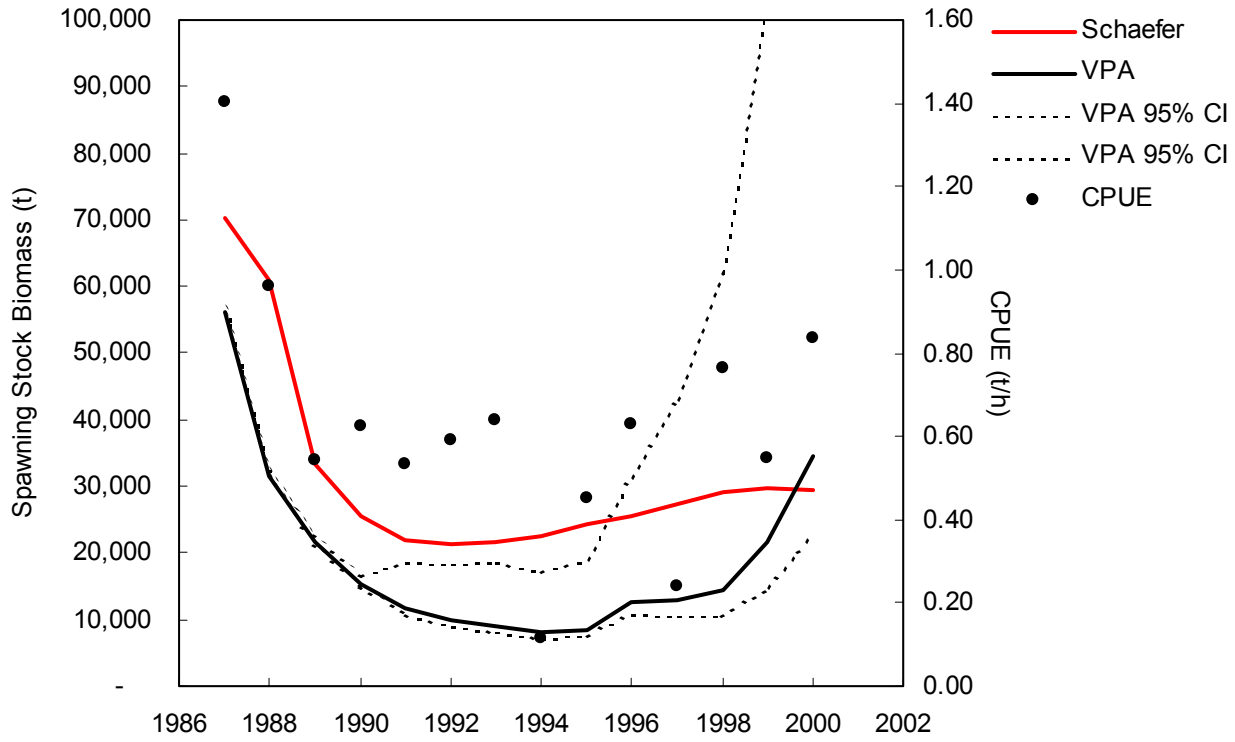

Figure 2. CPUE series for Spanish vessels fishing for hake in the Falkland Islands conservation zones, plus the spawning stock biomass estimates from two assessments based on data for area A.

An important feature of the VPA is a declining recruitment at age 3 between 1987 and 1992, which corresponds with the falling spawning stock biomass. There is therefore a strong suggestion that recruitment to the *M. hubbsi* population in the Falklands conservation zones is being affected by processes which are not explained in the available data (Fig 3).

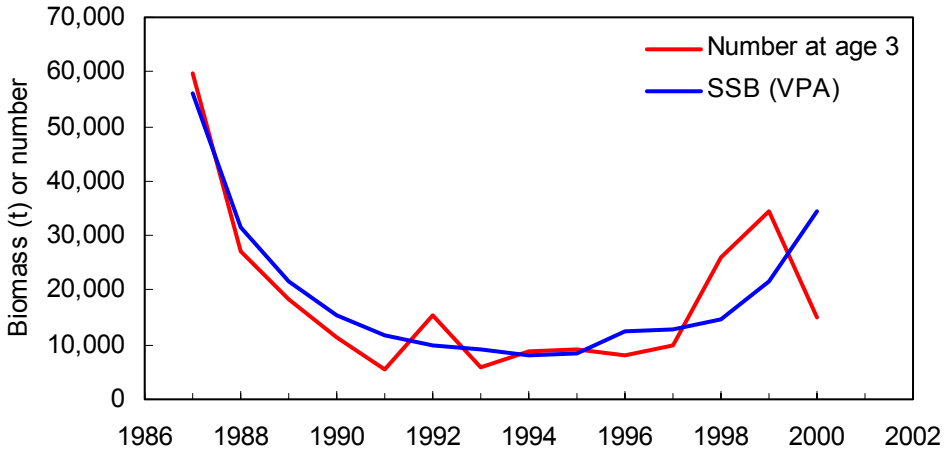

Figure 3. Estimated number of recruits at age 3 and spawning stock biomass from VPA of data from area A.

HYPOTHESIS 2: Area B contains a separate stock from area A, which might be part of the general Argentine stock.

In order to test this hypothesis CPUE series from areas A and B were compared with each other and with biomass estimates from an assessment of the Argentine stock (Renzi & Perez 2002). These biomass estimates were for 1st January, tuned to CPUE data from the previous year, whereas the area A and B CPUE series were for April to September. Correlations were therefore calculated between areas A and B, and Argentine biomass estimates for the following year (Fig. 4).

Abundance in area A and the Argentine EEZ both showed a steep fall at the end of the 1980s. Consequently there was a significant correlation between the two series ($r=0.61$, $P<0.05$). However, there was no significant correlation between the two series in the 1990s. The very low CPUE in area B in 1988 might have been due to low efficiency in the developing fishery rather than low abundance. With this point excluded, there was a positive relationship between area B and the Argentine EEZ ($r=0.66$, $P<0.05$). There was no correlation between areas A and B.

The correlation between area B and the Argentine EEZ suggests a link between area B and the general Argentine stock, while the lack of correlation between areas A and B, and area A and the Argentine EEZ suggests that these populations are not strongly linked.

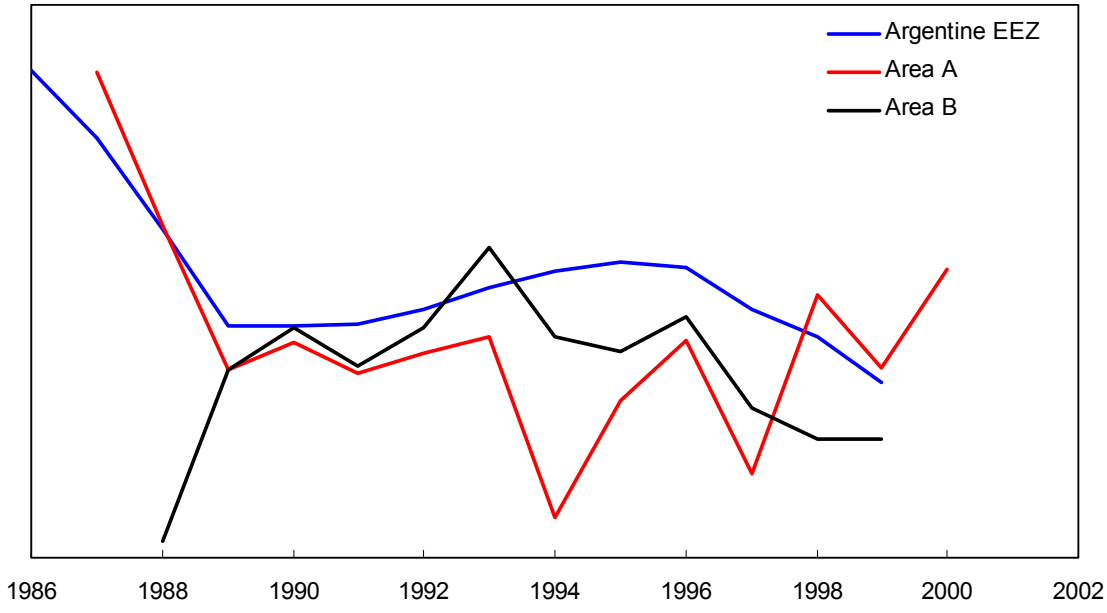

Figure 4. Abundance indices from areas A and B and the Argentine EEZ. Values are plotted to different vertical scales. Argentine data is plotted against assessment year –1 (see text).

HYPOTHESIS 3: The population in Area A is affected by fishing in the Argentine EEZ.

Although the correlation analysis showed little relationship between the overall population trends in area A and the Argentine EEZ, the VPA of area A alone suggested some external influence on recruitment. A likely candidate is fishing mortality in the Argentine EEZ, as the population in area A is likely to use inshore spawning and nursery areas. Such areas have been identified around San Jorge Gulf. The hypothesis has two components:

1) Spawning adults from area A suffer fishing mortality in the inshore spawning area around the San Jorge Gulf.
2) Pre-recruits suffer fishing mortality as by-catch in the Argentine shrimp fishery around San Jorge Gulf.

The Argentine authorities collect data on commercial hake catches by area, while the by-catch mortality can be estimated from data in Pettovello (1999). VPA assessments were conducted to address each of the sub-hypotheses individually. However, in neither case was it possible to determine the proportion of the catch that will ultimately affect the population in area A. The assessments therefore considered the hypotheses that area A was affected by either all adult hake catches in the San Jorge Gulf area, or by all juvenile hake by-catch in the southern San Jorge Gulf.

The assessment incorporating juvenile by-catch from the San Jorge Gulf region closely followed the assessment of area A as an independent stock in earlier years (Fig. 5). In recent years there were abrupt changes in trajectory in response to fluctuating catches of juveniles.

Catches of adult hake in the San Jorge Gulf region were up to 300,000 $t.y^{-1}$, so the assessment including these catches inevitably overestimated biomass compared to the assessment of area A as an independent stock. It also included a dramatic recovery in recent years as Argentine catches fell after the introduction of tighter catch controls in the San Jorge Gulf area in 1998. No evidence for such a recovery has been seen in catch rates for area A. What is known about vessel efficiency from the assessment of other stocks suggests that the stock size estimates are unlikely.

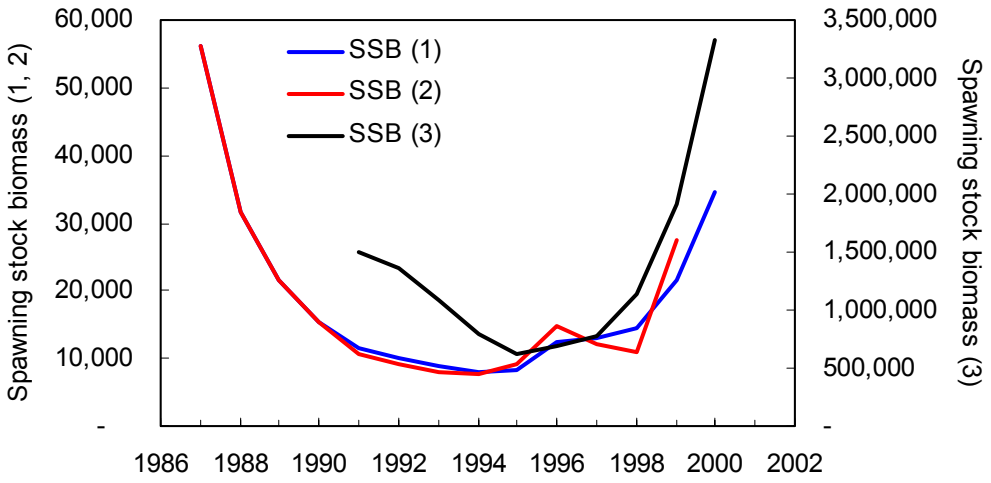

Figure 5. . Spawning stock biomass (in tonnes) of the population in area A estimated using Falklands conservation zone catch data only (1) and supplemented with San Jorge Gulf juvenile hake bycatch (2) or adult hake catches (3).

CONCLUSIONS

All of the assessments indicated a slight recovery of the stock from the mid 1990s.

The assessment of the population in area A as an independent stock does not adequately account for observed trends in recruitment at age 3.

Comparison of CPUE and biomass indices suggests that the populations in areas A and B are not closely linked but that the population in area B has followed the general Argentine stock in the 1990s. The population in area A did not follow the general Argentine stock. The results of the morphometric analysis from this project (presented at this conference) confirm that the populations in areas A and B are largely separate.

The population in area A is probably affected by fishing mortality occurring in inshore areas. Data on catches of spawning adults are not sufficiently well resolved to allow the part of the mortality associated with area A to be assessed. The assessment including juvenile by-catch mortality was more plausible, but the exact role of mortality outside area A (the Falklands conservation zones) is not well understood.

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